

Flexographic Ink Options

A Cleaner Technologies Substitutes Assessment

VOLUME 1

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Developed in Partnership by the Following Associations



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Contents

Preface	xi
Acknowledgments	xiii
Steering Committee	xv
Technical Committee	xvii
Participating Suppliers	xix
Abbreviations Used in the CTSA	xxi
Glossary	xxiii

VOLUME 1: TEXT

EXECUTIVE SUMMARY

BACKGROUND OF THE DFE FLEXOGRAPHY PROJECT	ES-2
POTENTIAL HAZARDS AND RISKS OF INK CHEMICALS	ES-4
Aquatic Hazards	ES-5
Human Health Hazards	ES-6
Human Health Risks	ES-7
PERFORMANCE	ES-11
COSTS	ES-14
RESOURCE USE AND ENERGY CONSERVATION	ES-15
FEDERAL ENVIRONMENTAL REGULATIONS	ES-16
CHOOSING AMONG FLEXOGRAPHIC INKS	ES-18
CONCLUDING REMARKS	ES-19

Chapter 1: INTRODUCTION TO THE CLEANER TECHNOLOGIES SUBSTITUTES ASSESSMENT

1.1 PROJECT BACKGROUND	1-1
1.2 WHAT IS A CLEANER TECHNOLOGIES SUBSTITUTES ASSESSMENT?	1-2
CTSA Methodology	1-2
1.3 WHO WILL BENEFIT FROM THIS CTSA?	1-3
1.4 OVERVIEW OF THE CTSA	1-3

Chapter 2: OVERVIEW OF FLEXOGRAPHIC PRINTING

2.1 INTRODUCTION TO FLEXOGRAPHIC INKS	2-3
Ink Components	2-3
Ink Systems	2-4
2.2 MARKET PROFILE OF THE FLEXOGRAPHIC PRINTING INDUSTRY	2-7
Descriptions of Different Flexography Market Segments	2-7
Market-Related Trends in the Flexographic Printing Industry	2-11
Markets for Printing Inks	2-13
Markets for Flexographic Inks	2-16
Imports and Exports for Flexographic Inks	2-17
2.3 FEDERAL REGULATIONS	2-19
Clean Air Act	2-19
Resource Conservation and Recovery Act	2-21
Toxic Substances Control Act	2-24
Clean Water Act	2-38
Safe Drinking Water Act	2-31
Comprehensive Environmental Response, Compensation, and Liability Act	2-31
Emergency Planning and Community Right-to-Know Act	2-32
Occupational Safety and Health Act	2-33
2.4 PROCESS SAFETY ASSESSMENT	2-41
Safety Hazards of Ink Formulations	2-41
Process Safety Concerns	2-44
REFERENCES	2-47

Chapter 3: RISK

3.1 INTRODUCTION TO RISK	3-4
Background	3-4
Quantitative Expressions of Hazard and Risk	3-5
Definitions of Systemic Toxicity, Developmental Toxicity, and Carcinogenic Effects	3-6
Definition of Aquatic Toxicity	3-8
3.2 HUMAN HEALTH AND ECOLOGICAL HAZARDS	3-9
Human Health Hazards	3-9
Ecological Hazards	3-25
3.3 CATEGORIZATION OF FLEXOGRAPHIC INK CHEMICALS FOR THIS CTSA	3-29
Chemical Categories by Ink Formulation	3-32
3.4 ENVIRONMENTAL AIR RELEASE ASSESSMENT	3-36
Environmental Air Release Methodology	3-36
Environmental Air Release Results	3-37
3.5 OCCUPATIONAL EXPOSURE ASSESSMENT	3-40
Occupational Exposure Methodology	3-40
Occupational Exposure Results	3-43
3.6 GENERAL POPULATION EXPOSURE ASSESSMENT	3-46
General Population Exposure Methodology	3-46
General Population Exposure Results	3-49

3.7 RISK CHARACTERIZATION	3-52
Risk Characterization Methodology	3-52
Occupational Risk Results	3-53
General Population Risk Results	3-60
REFERENCES	3-65

Chapter 4: PERFORMANCE

4.1 METHODOLOGY	4-4
Methodology for On-site Performance Demonstrations	4-4
Tests Performed on Samples from Performance Demonstrations and Laboratory Runs	4-5
Inks Used for the Study	4-11
Substrates Used for the Tests	4-11
Image and Plates Used for the Tests	4-12
Types of Printing Performed	4-12
Limitations of the Performance Demonstrations	4-12
Methodology for Laboratory Runs	4-13
4.2 RESULTS OF PERFORMANCE DEMONSTRATION AND LABORATORY RUN TESTS — SOLVENT-BASED AND WATER-BASED INKS	4-17
Adhesive Lamination — Solvent-based and Water-based Inks	4-17
Block Resistance — Solvent-based and Water-based Inks	4-18
CIE L*a*b* — Solvent-based and Water-based Inks	4-18
Coating Weight — Solvent-based and Water-based Inks	4-20
Density — Solvent-based and Water-based Inks	4-23
Dimensional Stability — Solvent-based and Water-based Inks	4-25
Gloss — Solvent-based and Water-based Inks	4-26
Heat Resistance/Heat Seal — Solvent-based and Water-based Inks	4-27
Ice Water Crinkle Adhesion — Solvent-based and Water-based Inks	4-28
Image Analysis — Solvent-based and Water-based Inks	4-29
Jar Odor — Solvent-based and Water-based Inks	4-30
Mottle/Lay — Solvent-based and Water-based Inks	4-32
Opacity — Solvent-based and Water-based Inks	4-34
Rub Resistance — Solvent-based and Water-based Inks	4-34
Tape Adhesiveness — Solvent-based and Water-based Inks	4-35
Trap — Solvent-based and Water-based Inks	4-36
Highlights of Performance Results for Solvent-Based and Water-Based Inks	4-38
4.3 RESULTS OF PERFORMANCE DEMONSTRATION AND LABORATORY RUN TESTS — UV-CURED INKS	4-38
Block Resistance — UV-cured Inks	4-39
CIE L*a*b* — UV-cured Inks	4-40
Coating Weight — UV-cured Inks	4-41
Coefficient of Friction — UV-cured Inks	4-42
Density — UV-cured Inks	4-43
Dimensional Stability — UV-cured Inks	4-44
Gloss — UV-cured Inks	4-44
Ice Water Crinkle Adhesion — UV-cured Inks	4-45
Image Analysis — UV-cured Inks	4-45
Jar Odor — UV-cured Inks	4-47
Mottle/Lay — UV-cured Inks	4-48
Opacity — UV-cured Inks	4-49
Rub Resistance — UV-cured Inks	4-50

Tape Adhesiveness — UV-cured Inks	4-50
Trap — UV-cured Inks	4-50
Uncured Residue — UV-cured Inks	4-51
Summary of Performance Test Results for UV-Cured Inks	4-51
Technological Development in UV-cured Inks	4-52
4.4 SITE PROFILES	4-54
Site 1: Water-based Ink #W2 on OPP	4-55
Site 2: Water-based Ink #W3 on LDPE and PE/EVA	4-57
Site 3: Water-based Ink #W3 on LDPE and PE/EVA	4-59
Site 4: Water-based Ink #W1 on OPP	4-61
Site 5: Solvent-based Ink #S2 on LDPE and PE/EVA	4-62
Site 6: UV Ink #U2 on LDPE, PE/EVA, and OPP	4-64
Site 7: Solvent-based Ink #S2 on LDPE and PE/EVA	4-66
Site 8: UV Ink #U3 on LDPE, PE/EVA, and OPP	4-68
Site 9A: Water-based Ink #W4 on OPP	4-70
Site 9B: Solvent-based Ink #S1 on OPP	4-71
Site 10: Solvent-based Ink #S2 on OPP	4-73
Site 11: UV Ink #U1 on LDPE (no slip)	4-75
REFERENCES	4-77

Chapter 5: COST

5.1 DEVELOPMENT OF COSTS	5-3
Material Costs	5-3
Labor Costs	5-7
Capital Costs for New Presses	5-10
Capital Costs for Retrofitting a Press	5-13
Energy Costs	5-15
Uncertainties	5-15
5.2 COST ANALYSIS RESULTS	5-17
Summary of Cost Analysis Results	5-17
Discussion of Cost Analysis Results	5-20
5.3 DISCUSSION OF ADDITIONAL COSTS	5-24
Regulatory Costs	5-24
Insurance and Storage Requirements	5-25
Other Environmental Costs and Benefits	5-25
REFERENCES	5-26
ADDITIONAL REFERENCES	5-27

Chapter 6: RESOURCE AND ENERGY CONSERVATION

6.1 INK AND ADDITIVE CONSUMPTION	6-3
Methodology	6-3
Limitations and Uncertainties	6-5
Ink and Additive Consumption Estimates	6-6
6.2 ENERGY CONSUMPTION	6-10
Methodology	6-10
Limitations and Uncertainties	6-16
Energy Consumption Estimates	6-17
6.3 ENVIRONMENTAL IMPACTS OF ENERGY REQUIREMENTS	6-23
Emissions from Energy Production	6-23
Environmental Impacts of Energy Production	6-25
Limitations and Uncertainties	6-25
6.4 CLEAN-UP AND WASTE DISPOSAL PROCEDURES	6-28
Press Clean-Up and Waste Reduction in the CTSA Performance Demonstrations	6-29
REFERENCES	6-31

Chapter 7: ADDITIONAL IMPROVEMENT OPPORTUNITIES

7.1 POLLUTION PREVENTION OPPORTUNITIES	7-3
7.2 RECYCLING AND RESOURCE RECOVERY	7-8
Silver Recovery	7-8
Solvent Recovery	7-8
Solid Waste Recycling	7-8
7.3 CONTROL OPTIONS	7-9
Sources of Flexographic Ink Pollutants Amenable to Treatment or Control Options	7-9
Control Options and Capture Devices for Air Releases	7-10
Control Options for Liquid Releases	7-12
REFERENCES	7-14

Chapter 8: CHOOSING AMONG INK TECHNOLOGIES

8.1 SUMMARY BY INK SYSTEM AND PRODUCT LINE	8-2
Introduction	8-2
Solvent-based Inks	8-14
Water-based Inks	8-17
UV-cured Inks	8-20
8.2 QUALITATIVE SOCIAL BENEFIT-COST ASSESSMENT	8-24
Introduction to Social Benefit-Cost Assessment	8-24
Benefit-Cost Methodology and Data Availability	8-26
Potential Private and Public Costs	8-26
Potential Private and Public Benefits	8-31
Summary of Social Benefit-Cost Assessment	8-34

8.3 DECISION INFORMATION SUMMARY	8-36
Introduction	8-36
Ink System Comparison	8-37
Highlights of Chemical Category Information	8-41
Hazard, Risk and Regulation of Individual CTSA Chemicals	8-46
Suggestions for Evaluating and Improving Flexographic Inks	8-63
REFERENCES	8-66

VOLUME 2: APPENDICES TO ALL CHAPTERS

Appendices to Chapter 3: RISK

Appendix 3-A: Flexographic Ink Formulations and Structures
Appendix 3-B: Human Health and Ecological Hazard Results
Appendix 3-C: Supplementary Environmental Air Release Information
Appendix 3-D: Environmental Air Release Data
Appendix 3-E: Supplemental Occupational Exposure Assessment Methodology
Appendix 3-F: Occupational Exposure Data
Appendix 3-G: Supplementary General Population Exposure Information
Appendix 3-H: General Population Exposure Data
Appendix 3-I: Systemic Toxicity Risk Results
Appendix 3-J: Developmental Toxicity Risk Results
Appendix 3-K: Summary of Occupational Systemic Toxicity Risk — Dermal
Appendix 3-L: Summary of Occupational Systemic Toxicity Risk — Inhalation
Appendix 3-M: Summary of Occupational Developmental Toxicity Risk — Dermal
Appendix 3-N: Summary of Occupational Developmental Toxicity Risk — Inhalation
Appendix 3-O: Summary of General Population Systemic Toxicity Risk — Inhalation
Appendix 3-P: Summary of General Population Developmental Toxicity Risk — Inhalation

Appendices to Chapter 4: PERFORMANCE

Appendix 4-A: Overall Performance Demonstration Methodology
Appendix 4-B: Facility Background Questionnaire
Appendix 4-C: Performance Demonstration Data Collection Form
Appendix 4-D: Test Image Design
Appendix 4-E: Laboratory Test Procedures and Performance Data
Appendix 4-F: Anilox Configuration Data from the Performance Demonstrations
Appendix 4-G: Surface Tension Data from the Performance Demonstrations
Appendix 4-H: Viscosity Data from the Performance Demonstrations
Appendix 4-I: Descriptions and Test Data for Performance Demonstration Sites
Appendix 4-J: Descriptions and Performance Test Data for the Laboratory Runs
Appendix 4-K: Performance Test Data from Laboratory Runs for Inks Not Used in the Performance Demonstrations

Appendices to Chapter 5: COST

Appendix 5-A: Cost Analysis Methodology
Appendix 5-B: Supplemental Cost Analysis Information

Appendices to Chapter 6: RESOURCE AND ENERGY CONSERVATION

Appendix 6-A: Supplemental Resource and Energy Conservation Information
Appendix 6-B: Clean-Up and Waste Disposal Procedures for Each Site
Appendix 6-C: Pollution Generation Reports

Preface

This draft report, *Flexographic Ink Options: A Cleaner Technologies Substitutes Assessment*, presents the findings and analysis of a voluntary, cooperative effort between the flexographic printing industry and the U.S. EPA. This is not an official guidance document and should not be relied on by companies in the printing industry to determine regulatory requirements. Information on cost and product usage in this document was provided by individual product vendors and has not been corroborated by EPA. Mention of specific company names or products does not constitute an endorsement by EPA.

Comments are welcome on all aspects of the draft CTSA. Please send comments by November 30, 2000, to:

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Emerald Packaging
Enercon Industries
Fine Line Graphics
Flex Pack
Flint Ink
Harper Corporation of America
INX International
Lawson Mardon Packaging USA
MacDermid Graphic Arts
Maine Poly
Mobil Chemical Corp.
Progressive Inks
Roplast Industries
Sun Chemical Corporation
Windmoeller & Hoelscher Corp.

Abbreviations Used in the CTSA

ADC	Average Daily Concentration
ADD	Average Daily Dose
BACT	Best Available Control Technology
BCM	Billion Cubic Microns per Square Inch
BOD	Biological Oxygen Demand
CAA	Clean Air Act
CAS	Chemical Abstracts Service Registry Number
CBI	Confidential Business Information
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESQG	Conditionally Exempt Small Quantity Generator
CTG	Control Technology Guidelines
CTSA	Cleaner Technology Substitutes Assessment
CWA	Clean Water Act
DfE	Design for the Environment
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
FOG	Fat/Oil/Grease
FPA	Flexible Packaging Association
FTA	Flexographic Technical Association
FWPCA	Federal Water Pollution Control Act
HAP	Hazardous Air Pollutant
HQ	Hazard Quotient
HSWA	Hazardous and Solid Waste Amendments
IARC	International Agency for Research on Cancer
LDPE	Low-Density Polyethylene
LEPC	Local Emergency Planning Commission
LOAEL	Lowest Observed Adverse Effect Level
LQG	Large Quantity Generator
MACT	Maximum Achievable Control Technology
MEK	Methyl Ethyl Ketone
MIBK	Methyl Isobutyl Ketone
MOE	Margin of Exposure
MSDS	Material Safety Data Sheet
NAICS	North American Industry Classification System

NAPIM	National Association of Printing Ink Manufacturers
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NOAEL	No Observed Adverse Effect Level
NPDES	National Pollution Discharge Elimination System
OPP	Oriented Polypropylene
OPPT	Office of Pollution Prevention and Toxics
OSHA	Occupational Safety and Health Administration
PE/EVA	Polyethylene/Ethylvinyl Acetate
POTW	Publicly Owned Treatment Works
PTE	Permanent Total Enclosure
RACT	Reasonably Achievable Control Technology
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SERC	State Emergency Response Commission
SIC	Standard Industrial Classification
SQG	Small Quantity Generator
TRI	Toxics Release Inventory
TSD	Treatment, Storage, and Disposal (facility)
TSS	Total Suspended Solids
UST	Underground Storage Tank
VOC	Volatile Organic Compound

Glossary

Acetate	a family of solvents also known as esters of acetic acid
Acrylate	a chemical functional group commonly used in UV curing
Acute exposure	one dose or multiple dose exposures occurring over a short time (24 hours)
Additive	a substance used in small quantities to modify the properties of an ink
Adhesion	state in which two surfaces are held together by molecular forces; measure of the strength with which one material sticks to another
Adhesive	any material that is applied to one or more surfaces to form a bond between the two
Adsorbent	material (e.g., carbon) that adsorbs (concentrates) a substance on its surface
Adsorption	accumulation of a gaseous, liquid, or dissolved substance on the surface of a solid
Ambient environment	the existing conditions in the environment or immediate vicinity
Amide	a nitrogen-containing compound that usually is basic (alkaline)
Anilox roll	engraved steel and chrome-coated metering roll to control the amount of ink sent from the fountain roller to the printing plates
Anilox volume	the volume of cells on an anilox roll in a standardized area, expressed as billion cubic microns per square inch (BCM)
Aquatic toxicity	capability of a substance to cause adverse effects in aquatic organisms
Benefit	the value to society of a good or service. From a firm's perspective, the benefit of a good or service can be measured by the revenue the firm receives from its sales as compared to the costs incurred when producing its products. From the consumer's perspective, the benefit can be measured by what the consumer would be willing to pay for the good or service. Some goods and services, such as environmental amenities and health risk reductions, are not generally for sale in a market economy. However, these goods and services do provide benefits to society which should be recognized. Economists attempt to estimate the value of these goods and services through various nonmarket valuation methods.
Best Available Control Technology (BACT)	an emission limitation based on the maximum degree of emission reduction (considering energy, environmental, and economic impacts) achievable through application of production processes and available methods, systems, and techniques; (EPA) the most stringent technology available for controlling emissions; major sources are required to use BACT, unless it can be demonstrated that it is not feasible for energy, environmental, or economic reasons.
Block resistance	a type of performance test that measures the bond between ink and substrate when heat and pressure are applied

Blocking	undesired adhesion between layers of material that may cause damage to at least one surface upon their separation
Caliper	the thickness of a sheet or material measured under specific conditions, expressed in thousandths of an inch
Carcinogen	cancer-causing chemical
Carcinogenic effect	malignant tumor or other manifestation of abnormal cell growth caused by cancer
Catalyst	a substance that accelerates the rate of a reaction between two or more substances without being consumed in the process
Catalytic oxidizer	type of oxidizer that contains a catalyst
Cationic ink	a type of UV-cured ink in which photoinitiators start the reaction by causing an electron deficiency in the monomers and oligomers
Central impression printing press	printing press in which the material being printed is in continuous contact with a single-large diameter impression cylinder; the color stations are arranged around the circumference of the cylinder and imprint the image on the substrate
Chill roller	metal roll or drum with internal cooling, used to cool the printed web prior to rewinding
Coating	the outer covering of a film or web; the film may be coated on one or both sides
Co-extruded polyethylene/ethyl vinyl acetate (PE/EVA)	a type of film substrate used in flexographic printing
Co-extrusion	a process used to produce a product, such as a film substrate, by forcing more than one extruder through a common die
Colorant	a substance that provides the color associated with ink; it can be a pigment or a dye
Control option	add-on technological system or device that removes pollutants from a flexographic facility's waste stream and thereby keeps them out of air, water, and landfills; pollutants may be captured for reuse, recycling, or disposal
Conventional pollutant	a pollutant chemical in wastewater effluent regulated under the Clean Water Act (CWA); includes biological oxygen demand (BOD), total suspended solids (TSS), fecal coliform bacteria, fat/oil/greases (FOG), and pH
Core	a tube on which paper, film, or foil is wound for shipment; the metal body of a roller which is rubber covered
Corona treater	equipment that electrically charges the substrate to improve ink adhesion by raising the surface tension of the substrate
Corrosivity	capability of corroding
Cross-linker	a component of UV-cured inks. Such as a monomer or oligomer, that is capable of reacting to form a solid coating

Cure	process of treating inks with ultraviolet light which creates a bond between the monomers and oligomers in the ink; the reaction (or "drying") causes the ink to solidify and bind with the substrate
Curing agent	a chemical that participates in the reaction that results in the curing of UV inks
Dermal exposure	exposure through the skin
Developmental toxicity	adverse effects caused to a developing organism from exposure to a substance prior to conception, during prenatal development, or postnatally up to the time of sexual maturation
Die	any of various sharp cutting forms, used to cut desired shapes from papers, paperboard, plastics or other stocks
Diluent	a liquid with no solvent action, used to dilute or thin an ink or lacquer; a type of extender
Direct medical costs	costs associated specifically with the identification and treatment of a disease or illness (e.g., costs of visits to the doctor, hospital costs, costs of drugs). Discounting: Economic analysis procedure by which monetary valuations of benefits and/or costs occurring at different times are converted into present values which can be directly compared to one another.
Dispersant	material that enables a uniform distribution of solid particles
Dispersion	a uniform distribution of solid particles in a vehicle by mixing or milling
Doctor blade	a thin flexible blade that grazes the anilox roll at an angle to remove excess ink from the roll before the ink is applied to the printing plate
Dose-response assessment	in a risk assessment, the relationship between the dose of the chemical received and the incidence and severity of the adverse health effects in the exposed population
Dot gain	the undesired increase in size of a printed "dot" of ink
Dye	coloring material which is soluble in an ink vehicle, as opposed to pigments, which are not soluble, and must be dispersed
Electrolytic silver recovery	method of silver recovery whereby a current is passed between two electrodes in silver-laden water, plating the silver on the cathode in a virtually pure form
Exposed population	the estimated number of people from the general public or a specific population group who are exposed to a chemical, process, and/or technology. The general public could be exposed to a chemical through wide dispersion of a chemical in the environment (e.g., DDT). A specific population group could be exposed to a chemical due to its physical proximity to a manufacturing facility (e.g., residents who live near a facility using a chemical), through the use of the chemical or a product containing a chemical, or through other means.

Exposed worker population	the estimated number of employees in an industry exposed to the chemical, process, and/or technology under consideration. This number may be based on market share data as well as estimations of the number of facilities and the number of employees in each facility associated with the chemical, process, and/or technology under consideration
Exposure assessment	in risk assessment, identification of the pathways of which toxicants may reach individuals, estimation of how much of a chemical an individual is likely to be exposed to, and estimation of the number of people likely to be exposed
Epoxy resin	plastic or resinous materials used for strong, fast-setting adhesives, as heat resistant coatings and binders
Extender	any material added to inks to reduce its color strength and/or viscosity
External benefits	a positive effect on a third party who is not part of a market transaction. For example, if an educational program (i.e., a smoking-cessation class) results in behavioral changes which reduce the exposure of a population group to a disease (i.e., lung cancer), then an external benefit is experienced by those members of the group who did not participate in the educational program (i.e., those inhaling second-hand smoke). External benefits also occur when environmental improvements enhance enjoyment of recreational activities (e.g., swimming, hiking, etc.).
External costs	a negative effect on a third party who is not part of a market transaction. For example, if a steel mill emits waste into a river which poisons the fish in a nearby fishery, the fishery experiences an external cost to restock as a consequence of the steel production. Other examples of external costs are the effects of second-hand smoke on nonsmokers, increasing the incidence of respiratory distress, and a smokestack which deposits soot on someone's laundry, thereby incurring costs of laundering.
Externality	a cost or benefit that involves a third party who is not a part of a market transaction; "a direct effect on another's profit or welfare arising as an incidental by-product of some other person's or firm's legitimate activity" (Mishan, 1976). The term "externality" is a general term which can refer to either external benefits or external costs.
Extrusion	the production of a continuous product (e.g., a sheet of film) by forcing a material (e.g., thermoplastic) through a die or orifice
Flammability	the capability of burning
Flexible packaging	any package or part of packaging with a thickness of ten millimeters or less whose shape can be changed readily
Flexographic printing plate	a plate with a raised image that prints on the desired substrate
Formulation	a specific color (e.g., Reflex blue) within an ink product line used in the CTSA (e.g., solvent-based ink#1)
Fountain	a pan or trough on a press that serves as a reservoir for ink
Fountain roll	a press roll that picks up ink or coating material from the fountain and applies it to the transfer roll

Four-color process	printing with cyan, magenta, and yellow color inks plus black, and using combinations of these colors to create all other colors (see process printing)
Free radical	an unstable, reactive molecule that has a neutral charge (in comparison to an ion)
Free radical curing	a type of UV-cured ink in which the photoinitiators release reactive free radicals
Fugitive emissions	emissions that escape from the printing press and leave the facility through openings such as windows and doors
Hazard	potential for a chemical or other pollutant to cause human illness or injury; the inherent toxicity of a compound
Hazard identification	in a risk assessment, determining whether exposure to a chemical could cause adverse health effects in humans or in nature; an informed judgment based on verifiable toxicity data from animal models or human studies
Hazard quotient	the ratio of estimated site-specific exposure to a single chemical over a specified period to the estimated daily exposure level at which no adverse health effects are likely to occur
Hazardous	harmful to human health and the environment
Hazardous Air Pollutant (HAP)	air pollutants listed under the Clean Air Act (CAA) as being hazardous to human health and the environment
Hazardous waste	by-products of industrial activities that can pose a substantial or potential hazard to human health or the environment when improperly managed
Hazardous waste generator	a facility that produces hazardous waste
Human health benefits	reduced health risks to workers in an industry or business as well as to the general public as a result of switching to less toxic or less hazardous chemicals, processes, and/or technologies. An example would be switching to a less volatile chemical or a new method of storing or using a volatile, hazardous chemical, to reduce the amount of volatilization, thereby lessening worker inhalation exposures as well as decreasing the formation of photochemical smog in the ambient air.
Human health costs	the cost of adverse human health effects associated with production, consumption and disposal of a firm's product. An example is the cost to individuals and society of the respiratory effects caused by stack emissions, which can be quantified by analyzing the resulting costs of health care and the reduction in life expectancy, as well as the lost wages as a result of being unable to work.
Ignitability	capability of lighting on fire
Illness costs	a financial term referring to the liability and health care insurance costs a company must pay to protect itself against injury or disability to its workers or other affected individuals. These costs are known as illness benefits to the affected individual. Appendix J summarizes several cost of illness valuation methods.

Incineration	the process of burning to ashes with the intent of reducing harmful substances to more benign ones
Indirect medical costs	indirect medical costs associated with a disease or medical condition resulting from exposure to a chemical, product or technology. Examples would be the costs of decreased productivity of patients suffering a disability or death and the value of pain and suffering borne by the afflicted individual and/or family and friends.
Individual risk	an estimate of the probability of an exposed individual experiencing an adverse effect, such as "1 in 1,000" (or 10 ⁻³) risk of cancer.
Inhalation exposure	exposure through breathing
Ink pan	reservoir for ink
Ink splitter	a device that separates solids from fluids in waste ink and cleaning solutions, or removes pigments from water-based ink wastes using a porous cellulose material
In-line printing press	a multicolored press in which the color stations are mounted horizontally in a line; a press coupled to another operation such as bagmaking, sheeting, diecutting, creasing, etc.
Ion exchange	method of recovering silver from wash water or mixtures of wash waters, fixer and bleach fix, especially from dilute solutions
Laminate	to bond together two or more layers of material or materials
Line color printing	process of printing 'line work' such as text, display type and graphics
Liquid ink	low-viscosity ink
Low-density polyethylene (LDPE)	type of film substrate used for printing on packaging such as frozen food bags
Lowest Observed Adverse Effect Level (LOAEL)	lowest exposure level at which adverse effects to human health and/or the environment have been shown to occur
Major Source	under Title V of the Clean Air Act, a facility that has the potential to emit 10 tons per year or more of any individual Hazardous Air Pollutant (HAP), 25 tons per year or more of any combination of HAPs, or 100 tons per year or more of any air pollutant. The 100 TPY limit applies to facilities located in areas with relatively good air quality ("attainment areas"); the limit decreases in non-attainment areas.
Makeready	the preparation and correction of the printing plate before starting the print run, to insure uniformly clean impressions; all preparatory operations preceding production
Margin of exposure (MOE)	the ratio of the no-observed-adverse-effect-level (NOAEL) to the estimated exposure dose
Material Safety Data Sheet (MSDS)	a compilation of information required under the Occupational Safety and Health Administration (OSHA) Communication Standard on the identity of hazardous chemicals, health and physical hazards, exposure limits, and precautions of a product
Maximum Achievable Control Technology (MACT)	the emission standard for sources of air pollution requiring the maximum reduction of hazardous emissions, taking cost and feasibility into account

Metallic replacement	method of silver recovery whereby wastewater is passed through one or more steel wool filters in which silver in the wastewater is chemically replaced by iron from the filter
Monomer	an individual molecular unit that is capable of linking together to form polymers
Narrow web press	any printing press web that is less than 24 inches wide; narrow web presses are able to do multiple converting operations (e.g., diecutting) in the same pass with the printing
National Emission Standards for Hazardous Air Pollutants (NESHAP)	emissions standards set by EPA for air pollutants that may cause an increase in fatalities or in serious, irreversible, or incapacitating illness
Net benefit	the difference between the benefits and the costs. For a company this could be interpreted as revenue - costs, assuming that the revenue and the costs are fully determined.
No Observed Adverse Effect Level (NOAEL)	the highest exposure level that can occur without statistically or biologically significant adverse effects to human health and/or the environment
Non-conventional pollutant	any wastewater effluent pollutant regulated under the Clean Water Act (CWA) that is not identified as a conventional or priority pollutant
Oligomer	a low-weight polymer that is capable of further combination; the component of UV-cured inks that links together to form a solid coating
Opportunity cost	a hidden or implied cost incurred due to the use of limited resources such that they are not available for an alternative use. For example, the use of specific laborers in the production of one product precludes their use in the production of another product. The opportunity cost to the firm of producing the first product is the lost profit from not producing the second. Another example would be a case where in hiring legal representation to respond to a lawsuit, and due to limited financial resources, a firm must cancel a planned expansion. The opportunity cost of responding to the lawsuit is the lost gain from not expanding.
Oral exposure	exposure through eating or drinking contaminated substances
Oral toxicity	ability of a chemical to cause injury when ingested
Oriented polypropylene (OPP)	a film substrate noted for clarity, stiffness, and ability to form a strong barrier
Overprinting	the printing of one impression over another
Oxidation	the reaction of a chemical (such as VOCs) with oxygen; the process of combining with oxygen
Oxidizer	equipment that burns contaminated air to break down harmful substances (e.g., VOCs) into water, carbon dioxide and other gases
Ozone	a gas containing three oxygen molecules; at ground level it is a pollutant formed in part by the reaction of volatile organic compounds (VOCs) released by solvent-based inks; contributes to smog formation
Paste ink	high-viscosity ink

Permanent total enclosure	a structure that completely surrounds a source of air emissions, captures all VOC emissions, and sends them to a control device
Photoinitiator	the component of UV-cured inks that reacts with ultraviolet light to begin the curing process
Photopolymer	any mixture of materials that can change its own physical properties on exposure to ultraviolet or visible light
Pigment	insoluble substance used to give color to inks, paints and plastics
Pinholing	failure of a printed ink to form a complete continuous film; visible in the form of small holes in the printed area
Plasticizer	material (usually in liquid form) that is added to ink to improve the flexibility of dried ink
Pollution prevention	identification of substances, processes, and activities that create excessive waste products or pollutants, followed by reductions in pollution generation by altering or eliminating a process or materials
Polyethylene	a synthetic resin of high molecular weight resulting from the polymerization of ethylene gas under pressure.
Polymer	a compound formed by the linking together of simple molecules
Polymerization	a chemical reaction in which the molecules of a monomer are linked together to form large molecules
Polypropylene	a synthetic resin of high molecular weight resulting from the polymerization of propylene gas
Population risk	an aggregate measure of the projected frequency of effects among all exposed people, such as "four cancer cases per year."
Present value	the value in today's terms of a sum of money received in the future. Present Value is a concept which specifically recognizes the time value of money, i.e., the fact that \$1 received today is not the same as \$1 received in ten years time. Even if there is no inflation, \$1 received today can be invested at a positive interest rate (say 5 percent), and can yield \$1.63 in ten years; \$1 received today is the same as \$1.63 received ten years in the future. Alternately, the present value of \$1 received in ten years is \$0.61. The rate at which future receipts are converted into present value terms is called the discount rate (analogous to the interest rate given above). The formula for calculating present value is given in the Cost Analysis module.
Press-side solvent or additive	a product added to ink during a press run to improve the printing performance (e.g., to decrease viscosity)
Primer	a first coat intended to enhance subsequent printing
Priority pollutant	a toxic chemical found in wastewater effluent and regulated under the Clean Water Act (CWA)
Private (internalized) benefits	the direct gain received by industry or consumers from their actions in the marketplace. One example includes the revenue a firm obtains in the sale of a good or service. Another example is the satisfaction a consumer receives from consuming a good or service.

Private (internalized) costs	the direct negative effects incurred by industry or consumers from their actions in the marketplace. Examples include a firm's cost of raw materials and labor, a firm's costs of complying with environmental regulations, or the cost to a consumer of purchasing a product.
Process color printing	halftone color printing created by the color separation process; a piece of copy is broken down to the primary colors to produce individual halftones, which are then recombined at the press to replicate the full range of colors
Product line	a group of proprietary inks that are made by one manufacturer, share certain printing characteristics, include multiple colors, and are intended for use with a specific ink system (e.g., solvent-based)
Propylene	gas used in polymerization to form polypropylene
Publicly Owned Treatment Works (POTW)	a municipal or regional water treatment plant
Reactive diluent	a material in UV-cured inks that reduces the viscosity of the ink and reacts instead of volatilization upon curing
Reactivity	property of being able to decompose or react with other chemicals
Reasonably Available Control Technology (RACT)	technology required under the Clean Air Act to regulate the emissions of volatile organic compounds
Recycling	the practice of reducing environmental wastes by recovering and reprocessing waste materials, thereby reducing the use of virgin materials
Reducer	material used to alter the body, viscosity or color strength of ink
Reference concentration	lowest daily human exposure measured by continuous inhalation that does not have an appreciable risk of deleterious, non-cancerous effects during a lifetime
Reference dose	estimate of the lowest daily human exposure that does not have an appreciable risk of deleterious, non-cancerous effects during a lifetime (expressed as an oral dose per kilogram of body weight)
Repeat length	printing length of a plate cylinder, determined by one complete revolution of the plate cylinder gear
Reportable quantity	substance-specific amount of hazardous material reportable under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
Reproductive toxicity	biologically adverse effects on the female or male reproductive organs, the related endocrine system, or offspring
Resin	natural or synthetic complex organic substance with no distinct melting point, which in a solvent solution forms the binder portion of the flexographic ink
Reverse printing	printing on the underside of a transparent film; or a design in which an image or type is "dropped-out" and the background is printed
Risk	a measure of the probability that damage will occur to life, health, or some aspect of the environment as a result of exposure to a given hazard

Risk characterization	in risk assessment, the process of using hazard, dose-response, and exposure information to develop quantitative and qualitative expressions of risk
Scuffing	action of rubbing something against a printed surface
Silver recovery	process by which silver is recovered from printing wastewater
Smog-related emissions	gases, such as volatile organic compounds (VOCs), carbon monoxide, and nitrogen oxides (NO _x), that are released during printing or energy production operations and contribute to the formation of smog when exposed to sunlight
Social benefit	the total benefit of an activity that society receives, i.e., the sum of the private benefits and the external benefits. For example, if a new product prevents pollution (e.g., reduced waste in production or consumption of the product), then the total benefit to society of the new product is the sum of the private benefit (value of the product that is reflected in the marketplace) and the external benefit (benefit society receives from reduced waste).
Social cost	the total cost of an activity that is imposed on society. Social costs are the sum of the private costs and the external costs. Therefore, in the example of the steel mill, social costs of steel production are the sum of all private costs (e.g., raw material and labor costs) and the sum of all external costs (e.g., the costs associated with replacing the poisoned fish).
Solvent	medium used to dissolve a substance
Solvent-based ink	an ink containing more than 25% VOCs and formulated to dry via evaporation
Solvent recovery	process of recovering purified solvents from VOC emissions
Solvent resistance	the ability of a cured ink coating to resist removal during exposure to a solvent such as methyl ethyl ketone (MEK)
Stack emission	emissions that are collected from the printing press and are released through a roof vent or stack to the outside air, sometimes undergoing treatment to reduce the emissions
Stack printing press	press where the printing stations are placed one above the other, each with its own impression cylinder
Substrate	material upon which an image is printed
Systemic toxicity	adverse effects on any organ system following absorption and distribution of a chemical throughout the body
Thermal oxidizer	oxidizer that requires high operating temperatures (see Oxidizer)
Thinner	liquid, solvent, and/or diluent added to ink for dilution or thinning; a type of extender
Tone	color quality or value; a tint or shade of color
Toxic Chemical Release Inventory (TRI)	requirement under the Emergency Planning and Community Right-to-Know Act (EPCRA) requiring certain facilities to report release of specified chemicals

Toxicity	property of being harmful or poisonous
Trapping	printing of one color over another
Tropospheric Ozone	see Ozone
Turbidity	a condition in which the clarity of water is reduced because of the presence of sediment, pigment, or other suspended material
Ultraviolet light	electromagnetic radiation of shorter wavelength than visible light
UV-cured ink	ink that is cured by ultraviolet light rather than evaporation
Vehicle	liquid component of a printing ink; carries the ink from the ink pan to the substrate
Viscosity	resistance to flow
Volatile Organic Compounds (VOCs)	any organic (carbon-containing) compound that participates in atmospheric photochemical reactions except those designated by EPA as having negligible photochemical reactivity
Volatilization	passing from liquid to gaseous state; subject to rapid evaporation; having high vapor-pressure at room temperature
Waste generator	a facility that generates wastes and is responsible for determining whether the waste is hazardous and what classification may apply to a waste stream
Water-based ink	an ink containing less than 25% VOCs and formulated to dry via evaporation
Wetting	process by which a liquid wets the surface of a dissimilar material by reducing the surface tension of the liquid
Wide-web press	a printing press with a web that is greater than 24 inches wide, usually in the range of 50-60 inches
Willingness-to-pay	estimates used in benefits valuation intended to encompass the full value of avoiding a health or environmental effect, which are often not observable in the marketplace. For human health effects, the components of willingness-to-pay include the value of avoided pain and suffering, impacts on the quality of life, costs of medical treatment, loss of income, and, in the case of mortality, the value of a statistical life.